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ABSTRACT

The literature suggests a "concrete" to "abstract" hierarchy in concept acquisition. However, typical tests do not reflect this hierarchy. Studies have been reported in which an "abstract" option for an item was included in with a "concrete" option and with distractors. This procedure assumes that "abstract" and "concrete" behavior is on a common dimension. This study tests this assumption. Two tests were built: in one, each item had a "concrete" right answer with two distractors; in the other an "abstract" right answer appeared with two distractors. These tests were factor analyzed with subtests from the Iowa Tests of Basic Skills and the Cognitive Abilities Tests. The two experimental tests loaded on the first factor, suggesting a common dimension. (Author/GDC)

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DIMENSIONALITY OF "CONCRETE" AND "ABSTRACT" ACHIEVEMENT TEST ITEMS

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Abstract

The literature suggests a "concrete" to "abstract" hierarchy in concept acquisition. However, typical tests do not reflect this hierarchy. Studies have been reported in which an "abstract" option for an item was included in with a "concrete" option and with distractors. This procedure assumes that "abstract" and "concrete" behavior is on a common dimension. This study tests this assumption. Two tests were built; in one, each item had a "concrete" right answer with two distractors; in the other an "abstract" right answer appeared with two distractors. These tests were factor analyzed with subtests from the Iowa Tests of Basic Skills and the Cognitive Abilities Tests. The two experimental tests loaded on the first factor, suggesting a common dimension.

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Introduction

Classroom teachers and other educators have widely accepted the idea that the formation of specific concepts in children goes through definite ordered steps. However, achievement tests have not been adapted to correspond with these steps. The body of research points to the conclusion that concept development passes through successive levels. For example, Kogan (1966) stated that there are qualitatively different structures which characterize stages of concept development which occur from infancy through adolescence. Earlier research by Reichard, Schneider and Rapaport (1944) identified concept levels as follows:

1. The concretistic or descriptive method - impulsive memory of an object at the concrete sensory level.
2. The functional or usage method - a word is defined by the subject by having him recall the use to which that object was put.
3. Categorical or conceptual method - represents the abstract method of definition.

A close congruence has been found between these three levels identified by Reichard et al. and those proposed by Klausmeier (1971). His system proposes that there are four successive levels or concept types with corresponding cognitive operations:

1. Concrete - discriminating one object from others and remembering the discriminated object.
2. Identity - generalizing that two or more forms of the same object are equivalent.
3. Rudimentary classificatory - generalizing that two or more instances are equivalent in some way.
4. Formal concept - discriminating the attributes that define the concept.

Writers who have dealt with measurement of concept formation have generally found the idea of levels moving from "concrete" to

"abstract" as a useful frame of reference. For example, Feifel and Lorge (1950) found that young children perceived words as concrete ideas whereas older children emphasized the abstract or class features of word meaning. Kruglov (1953) constructed a multiple choice vocabulary test with several "correct" answers. Each of the correct answers represented a higher level of the concept. She found that the per cent of generalizations increased with grade or age and correspondingly there was a decrease in the per cent of explanation type responses.

Further work on the development of multi-level multiple choice tests has been done by Chase (1961,1969). These studies were designed to test the applicability of the Reichard, Schneider and Rapaport levels in measuring arithmetic concepts and in assessing reading comprehension. In both cases items were used in which each problem had three responses; a concrete answer, an abstract answer, and a distractor. High criterion performance students tended to choose the abstract alternative but low criterion performance students tended to choose the concrete response. Similar data are reported by Russell and Saadeh (1962).

The above studies have been developed on the hypothesis that the concrete to abstract continuum is indeed uni-dimensional. The research reviewed so far has assumed that the multi-level items could be placed on a one dimensional scale with concrete at one end and abstract at the other. It is the purpose of this study to test whether an hypothesis of uni-dimensionality for the concrete-abstract continuum is indeed warranted.

Method

The principal method used for demonstrating uni-dimensionality was factor analysis. The first step was to collect the measuring instruments that would be combined into the factor analytic study.

A list of fifteen arithmetic terms was compiled which were at least introduced at the 4th grade level. Two tests were made with Klausmeier's categories as a guide. In the first test for

each stimulus term a correct concrete (identity) response was written and two distractors. In the second test for each stimulus term one abstract option (formal concept) was prepared as the correct answer and two distractors. In this manner two tests were developed, one which contained concrete options as correct answers and the second in which abstract options were the right responses. The stimulus words were the same for both tests. An example of the items is given on page 9.

The terms with their respective choices were randomly ordered and presented as a single test with the provision that the two identical terms could not be within two items of each other. Therefore, the finished composite tests consisted of thirty items, half of which were "concrete" and half "abstract." Instructions to the students were to select the response which appeared to be the best definition of the term presented.

Other measures of achievement were obtained on the same students. They included the five scores from the Iowa Test of Basic Skills and the three scores from the Cognitive Abilities Test. Data were collected in the 4th and 6th grades in a school in a large metropolitan area, drawing from primarily a middle class socio-economic population. There were 64 fourth graders and 86 sixth graders.

The experimental test was scored in two parts. One score was found by adding up the number of correct selections on the abstract items, the other score was found by adding the number of items correct on the concrete scale. Therefore each student had two scores; one representing his performance on the concrete scale, one on the abstract scale.

The above two experimental tests, the five achievement tests, and three cognitive abilities tests were put into a factor analysis and a principal factor solution was done with an Equimax rotation, with Kaiser normalization utilized on all factors for an eigenvalue of .75 or greater. The factor analysis was done on the combined grade levels as well as on the separated grade levels. (See Table 2.)

Results

In Table 1 the unrotated factor matrix for the combined grades obtained through the use of the principal axis solution is presented. The factor matrix was rotated and the pattern of factor loadings for the two resulting factors was obtained. Factor 1 appears to be a verbal factor while Factor 2 appears to be non-verbal. The Mathematics test loaded fairly equally on the verbal and non-verbal factors. This appears reasonable since the test is made up of multiple choice items on concepts as well as simple computations.

The point of the factor analysis was to observe the loading pattern of the experimental tests. The experimental concrete test loaded .63 on the first factor, .24 on the second. The abstract test loaded .74 on the first factor, .31 on the second. It appears that the first factor is the principal condition reflected in each of these tests.

The spatial representation of the rotated factors is given in Figure 1. With a two factor solution the loadings of the test definitely form two clusters. The experimental tests appear clearly within the structure of the first cluster.

The data were next factor analyzed separately by grade level. The resulting loadings for the separated grades were extremely close to those for the combined grades.

Discussion

To date the developers in the area of multi-level concept testing have tentatively applied classical psychometric procedures to the building of their tests with *no evidence that the multi-level items were indeed on a common dimension.* The results of the present analysis are important in that they lend support to the hypothesis that the concrete and abstract scale is on a common dimension. The factor analystic solution obtained tends

to support this conclusion. It would now seem possible to construct, as several investigators have done (Kruglov 1953, Chase 1961,1969, Russell and Saadeh 1962), a single test with the concrete and abstract responses included with a distractor for each single item. The next step could be either to score the tests by counting the number of concrete choices made to accumulate a "concrete score" and likewise obtain an "abstract score" or by developing a scaling system which would weight concrete and abstract responses to develop a total score across all items.

The general conclusion of this study is that the items built around a concrete to abstract continuum may well be unidimensional. Adding the results of this study to the research and development of previous writers who have built tests to assess concept levels appears to point the way to creation of a multi-level multiple choice achievement test. If theorists such as Kogan, Klausmeier and Piaget are correct in their formulations of hierarchies of concept forms it is necessary that these levels of thinking be taken into account when we assess the achievement levels of children. The evidence appears to suggest that achievement tests can be built imbedding a conceptual hierarchy of responses within each item, and a scoring scheme can be developed which assumes the "concrete" responses to be on the same dimension as "abstract" responses.

TABLE 1

THE UNROTATED FACTOR MATRIX, PRINCIPAL AXIS SOLUTION

	FA_1	FA_2
Concrete	.65	-.18
Abstract	.78	-.18
Vocabulary	.89	-.18
Reading	.87	-.07
Language Skills	.88	-.07
Work·Study Skills	.92	-.11
Mathematics Skills	.86	.00
Quantitative	.83	.41
Verbal	.89	.02
Non Verbal	.68	.41

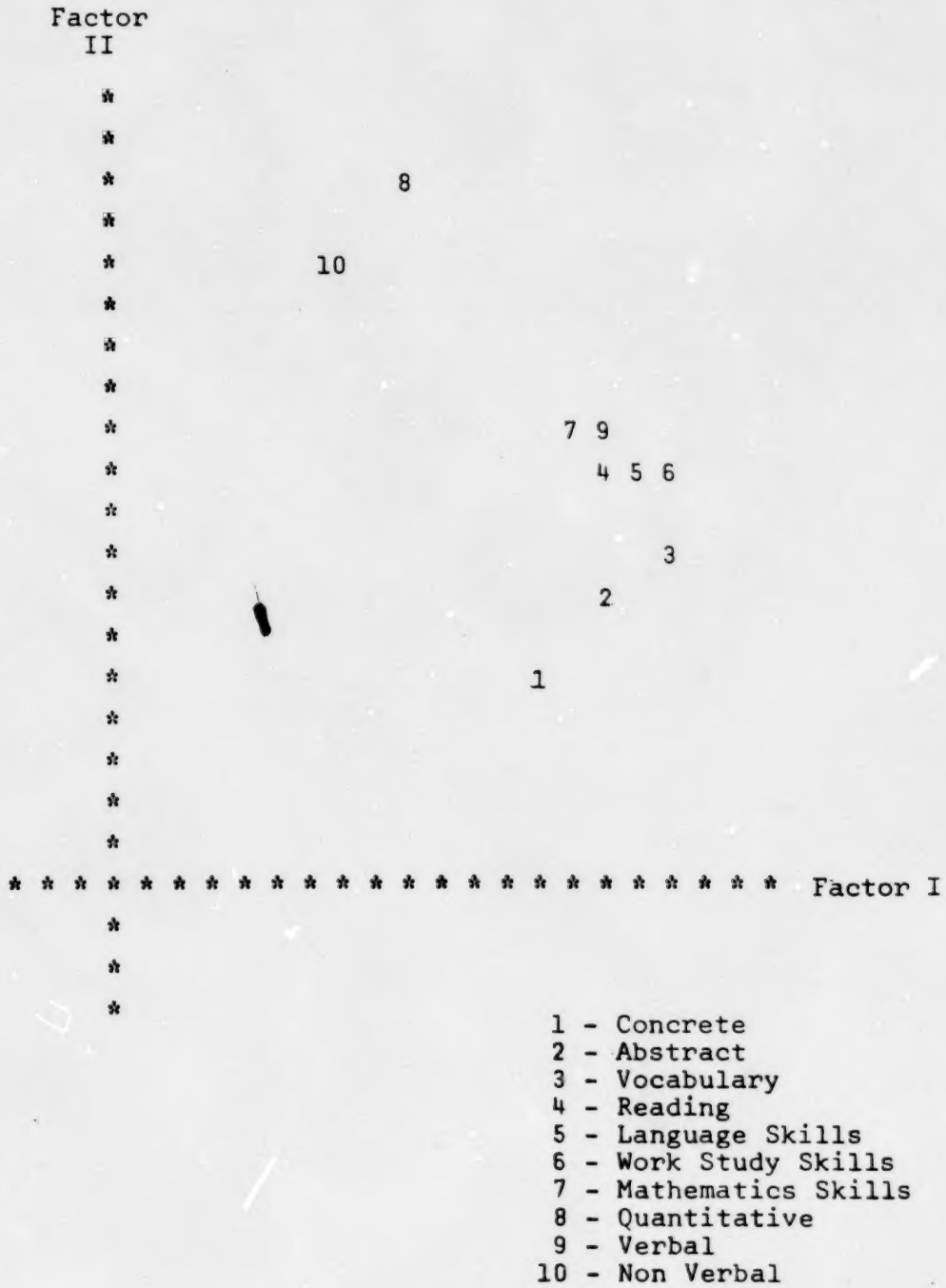
TABLE 2

THE FACTOR LOADINGS FOR EACH OF THE VARIABLES AFTER PRINCIPAL AXIS SOLUTION AND EQUIMAX ROTATION WITH KAISER NORMALIZATION

	Verbal (FA_1)	Non Verbal (FA_2)	Communality
1. Concrete	(.63)	.24	.46
2. Abstract	(.74)	.31	.64
3. Vocabulary	(.83)	.38	.83
4. Reading	(.74)	.46	.77
5. Language Skills	(.75)	.47	.79
6. Work Study Skills	(.81)	.46	.86
7. Mathematics Skills	.69	.51	.74
8. Quantitative	.43	(.82)	.86
9. Verbal	(.71)	.54	.79
10. Non Verbal	.31	(.73)	.63

FIGURE 1

A SPATIAL REPRESENTATION OF THE ITEM CLUSTERS OBTAINED IN THE TWO FACTOR SOLUTION



EXAMPLES OF TEST ITEMS

Concrete form of test item:

1. Dozen
   a) 12 eggs is a dozen
   b) the number 12 in base 6
   c) equal to the number of objects in base twelve

Abstract form of test item:

1. Dozen
   a) number of ounces in a pound
   b) any group of twelve
   c) equal to 4 quarts

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